LAW OFFICES
GOLDBERG, GODLES, WIENER & WRIGHT
1229 NINETEENTH STREET, N.W.
WASHINGTON, D.C. 20036

HENRY GOLDBERG
JOSEPH A. GODLES
JONATHAN L. WIENER
LAURA A. STEFANI
DEVENDRA ("DAVE") KUMAR

HENRIETTA WRIGHT
THOMAS G. GHERARDI, P.C.
COUNSEL

THOMAS S. TYCZ*
SENIOR POLICY ADVISOR
*NOT AN ATTORNEY

(202) 429-4900
TELECOPIER:
(202) 429-4912
general@g2w2.com

May 26, 2005

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Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ET Docket No. 04-151
WT Docket No. 05-96
ET Docket No. 02-380
ET Docket No. 93-237

Dear Ms. Dortch:

On May 25, 2006, Jose Albuquerque and Hazem Moakkit of PanAmSat, Jaime London (participating by telephone) of SES Americom, Humberto Henriques of Intelsat, and the undersigned, met with Ron Chase, Alan Scrime, Gary Thayer, Ahmed Lahjouji, Julius Knapp, Ira Keltz and George Sharp of the Office of Engineering and Technology; Nese Guendelsberger, Marty Liebman, Tom Stanley and David Furth of the Wireless Telecommunications Bureau; and Scott Kotler, Chip Fleming and Joseph Hill of the International Bureau to deliver the attached presentation relating to the above-referenced proceedings.

Please do not hesitate to address any questions to the undersigned.

Sincerely,

Joseph A. Godles
Attorney for PanAmSat Corporation

Attachment

cc: Ron Chase
Alan Scrime
Gary Thayer
Ahmed Lahjouji
Julius Knapp
Ira Keltz
George Sharp
Nese Guendelsberger
Marty Liebman
Tom Stanley
David Furth
Scott Kotler
Chip Fleming
Joseph Hill

Impact of Wireless Broadband Services in 3650-3700 MHz on FSS Operation in 3700-4200 MHz

Presentation by:
The Satellite Industry Association
at the FCC
Thursday May 25th, 2006

Relevant Documents:

- FCC R&O and MO&O, released March 16, 2005
- Satellite Industry Association (SIA) Petition for partial reconsideration, June 10, 2005
- SIA Opposition to petitions for reconsideration and comments, August 11, 2005
- SIA Reply to oppositions to petition for partial reconsideration, August 22, 2005.

Technical Characterization of Devices Providing Wireless Broadband Services in the 3650-3700 MHz band (FCC R&O and MO&O) :

- Fixed Devices:
  - Maximum EIRP in any direction not to exceed 25 Watts (44 dBm)
  - EIRP Density shall not exceed 25 Watts per 25 MHz (uniform distribution)
- Non-fixed Devices:
  - Maximum EIRP not to exceed 1 Watt (30 dBm)
  - EIRP Density shall not exceed 1 Watt per 25 MHz (uniform distribution)
- Emissions into adjacent bands shall be attenuated by at least 43 + 10 log(P)
- Allowable OOBE EIRP density level is uniform at -<u>43 dBW/MHz</u>

Mechanisms of Interference into FSS

- There are two main mechanisms of interference by the said devices into standard C-band FSS:
  - A.) Out-of-Band Emissions of Wireless Broadband devices into the adjacent FSS band (3700-4200 MHz)
  - B.) In-band emission of Wireless Broadband Devices (3650-3700 MHz) that are picked up by FSS receivers

INTERFERING SIGNAL

DESIRED FSS SIGNAL

3700 MHz

Calculation Assumptions:

- Calculations do not account for multi-path or multiple devices

- Two types of carriers are examined as follows:

Satellite Carrier Parameter	QPSK R3/4 DVB	8PSK R5/6 DVB (HDTV)
Allocated Bandwidth	36 MHz	36 MHz
Required C/(N+I)	7.5 dB	13 dB
Required C/I per ITU (C/N +12.2 dB)	7.5+12.2 = 19.7 dB	12+12.2 = 25.2 dB
Required C/I Criterion for our calculations	16.5 dB *(Required C/I to close typical link: see SIA reply to oppositions to petition for partial reconsideration)*	22 dB *(Required C/I to close typical link: see SIA reply to oppositions to petition for partial reconsideration)*
Receive Earth Station	3.7 m (G/T ~18 dB/K)	3.7 m (G/T ~18 dB/K)
Downlink EIRP at Receive Site	40 dBW	40 dBW

A.) OOBE by Wireless Broadband Devices into the adjacent FSS band:

- The OOB emissions from Wireless Broadband Devices Operating in 3650-3700 MHz fall in the adjacent 3700-4200 MHz band used by the FSS; i.e., “In-Band” from FSS standpoint
- The FSS earth stations cannot filter out “In-Band” signals
- OOBE levels of Wireless Broadband Services need to be sufficiently low in order not to impact FSS operations in the 3700-4200 MHz band

Sample OOBE Calculations:

Distance to Victim Antenna (meters)	Free Space Loss (dB)	Signal Level @ Victim Antenna (dBm/36 MHz)	Arrival Angle of Interferer (°)	Gain of Victim Antenna in direction of Interferer (dBi)	Effective Signal Level of Interferer @ Victim Antenna (dBm/36 MHz)	Achieved C/I level	C/I Margin (QPSK)	C/I Margin (8PSK)
50	77.7	-75.1	5	11.5	-63.6	-21.4	**-37.9**	**-43.4**
200	89.7	-87.1			-75.6	-9.4	**-25.9**	**-31.4**
600	99.3	-96.7			-85.1	0.1	**-16.4**	**-21.9**
1000	103.7	-101.1			-89.6	4.6	**-11.9**	**-17.4**
50	77.7	-75.1	15	2.6	-72.5	-12.5	**-29.0**	**-34.5**
200	89.7	-87.1			-84.5	-0.5	**-17.0**	**-22.5**
600	99.3	-96.7			-94.1	9.1	**-7.4**	**-12.9**
1000	103.7	-101.1			-98.5	13.5	**-3.0**	**-8.5**
50	77.7	-75.1	30	-4.9	-80.0	-5.0	**-21.5**	**-27.0**
200	89.7	-87.1			-92.1	7.1	**-9.4**	**-14.9**
600	99.3	-96.7			-101.6	16.6	**0.1**	**-5.4**
1000	103.7	-101.1			-106.0	21.0	**4.5**	**-1.0**
50	77.7	-75.1	45	-9.3	-84.4	-0.6	**-17.1**	**-22.6**
200	89.7	-87.1			-96.5	11.5	**-5.0**	**-10.5**
600	99.3	-96.7			-106.0	21.0	**4.5**	**-1.0**
1000	103.7	-101.1			-110.4	25.4	**8.9**	**3.4**

- OOBE EIRP density: -43 dBW/MHz
- Typical satellite signal level at LNB flange: 40 -196 +41+30= -85 dBm/36 MHz

Observations:

- The C/I criteria is not met for either QPSK or 8PSK type carriers
- 8PSK carriers are inherently more sensitive and are increasingly used for HDTV distribution
- A Wireless Broadband Device that complies with the FCC's OOB level could interfere with FSS Earth stations even with 1000 meter separation (see previous table)

Proposed Limits for OOBE

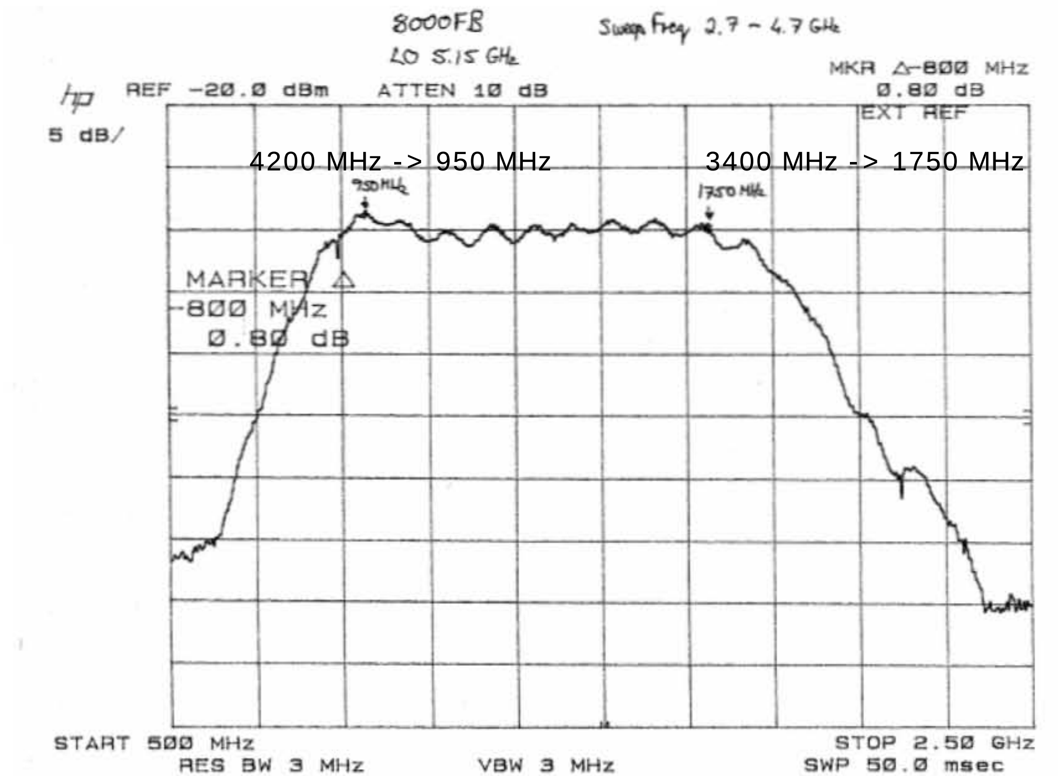
- Wireless Broadband Devices as described in the FCC order have more in common with unlicensed devices than with licensed ones
- The OOB limit contained in the FCC Order (-43 dBW/MHz) leads to significant C/I deficits
- In view of the above it is proposed that the OOBE limit for Wireless Broadband Devices be equal to that currently applicable to unlicensed devices, i.e., -71.25 dBW/MHz

B: Emissions in the 3650-3700 MHz band that are picked up by FSS receivers:

- FSS receiver is susceptible to signals transmitted in the adjacent band
- There is a great disparity in signal level between satellite signals in the 3700-4200 MHz band and Wireless Broadband Device signals in the 3650-3700 MHz band
- Wireless Broadband Emissions in the 3650-3700 MHz band can saturate FSS receiver “LNB”
- Typical LNB saturation level is -55 dBm (-85 dBW)
- LNBs, by design, do not reject signals in the 3650-3700 MHz range (see next figure)
- As shown later, this problem cannot be resolved even with the insertion of a band-pass filter before the LNB

Typical frequency response of a C-band LNB:

- LNB Local Oscillator Frequency = 5150 MHz
- Therefore,
  - 5150 – 4200 = 950 MHz (spectrum is inverted)
  - 5150 – 3400 = 1750 MHz
- LNBs do not provide any OOB filtering



LNB saturation analysis if no filters are used:

Distance to Victim Antenna (meters)	Free Space Loss (dB)	Signal Level @ Victim Antenna (dBm)	Arrival Angle of Interferer (°)	Gain of Victim E/S Antenna in direction of Interferer (dBi)	Effective Signal Level of Interferer @ Victim Antenna (dBm)	Total Power of Satellite Signal + Interferer (dBm)	Exceedance above LNB Saturation Level (dB)
50	77.7	-33.7	5	11.5	-22.2	-22.18	**32.8**
200	89.7	-45.7			-34.2	-34.22	**20.8**
600	99.3	-55.3			-43.8	-43.76	**11.2**
1000	103.7	-59.7			-48.2	-48.19	**6.8**
50	77.7	-33.7	15	2.6	-31.1	-31.11	**23.9**
200	89.7	-45.7			-43.2	-43.15	**11.9**
600	99.3	-55.3			-52.7	-52.66	**2.3**
1000	103.7	-59.7			-57.1	-57.05	**-2.0**
50	77.7	-33.7	30	-4.9	-38.6	-38.63	**16.4**
200	89.7	-45.7			-50.7	-50.66	**4.3**
600	99.3	-55.3			-60.2	-60.05	**-5.0**
1000	103.7	-59.7			-64.7	-64.20	**-9.2**

Assumptions:

- EIRP of the interfering signal: a single 25 watts per 25 MHz in 3650-3700 MHz
- Typical combined power of 12 transponders in a given polarization as seen at the LNB flange: 40 -196 + 41 + 30 + 10log12 = -74.2 dBm
- LNB saturation level: -55 dBm (based on manufacturer information)

Graphical Representation of Interference and Band-Pass Filters

Band Pass Filter Response
(Pass Band: 3.7 - 4.2 GHz)

Filter
Attenuation
“X”

INTERFERING SIGNAL 25 MHz

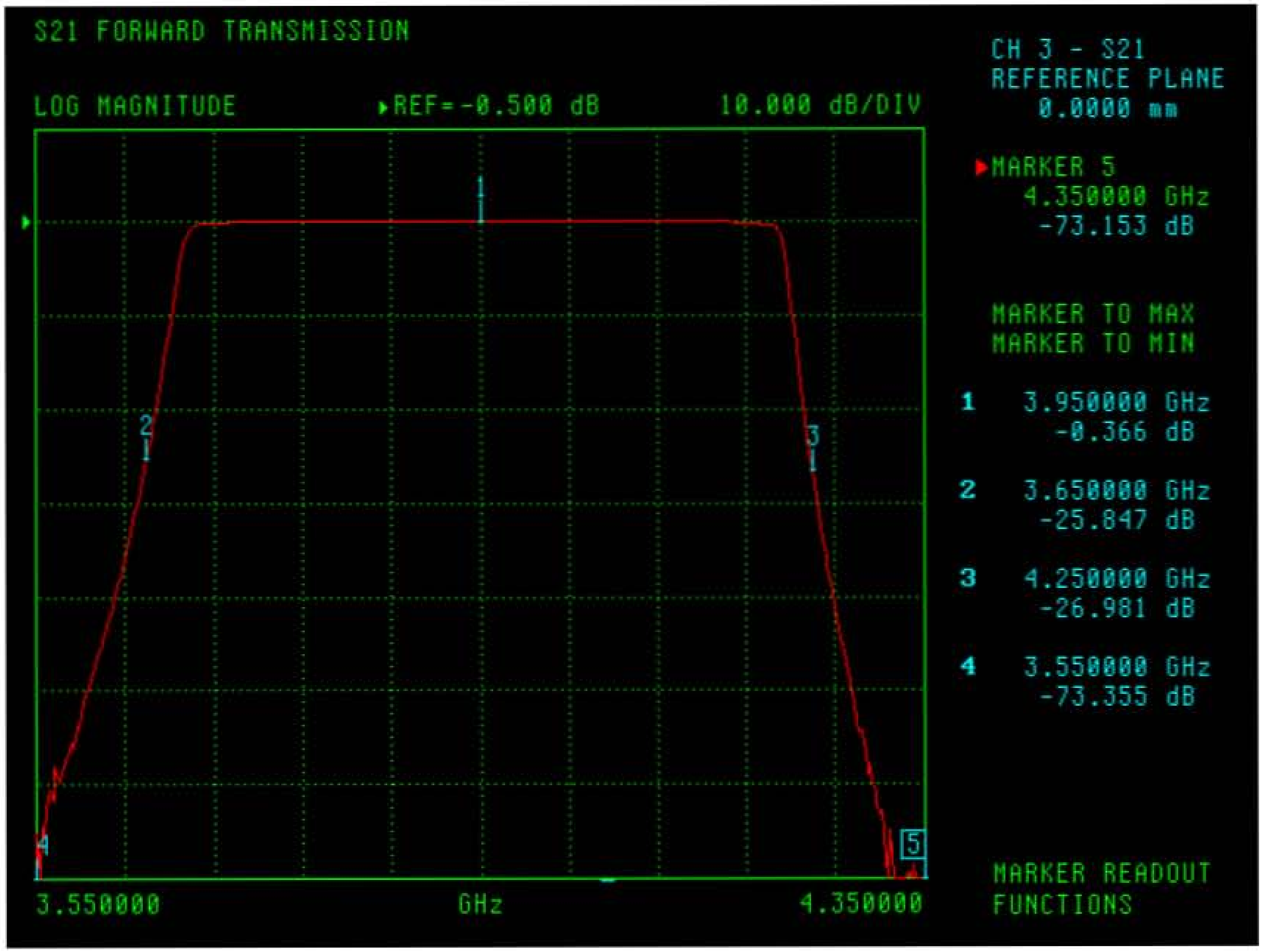
INTERFERING SIGNAL 25 MHz

Satellite Signal 36 MHz

3650 MHz

3700 MHz

Typical frequency response of band-pass filters commonly used in C-band FSS earth stations:

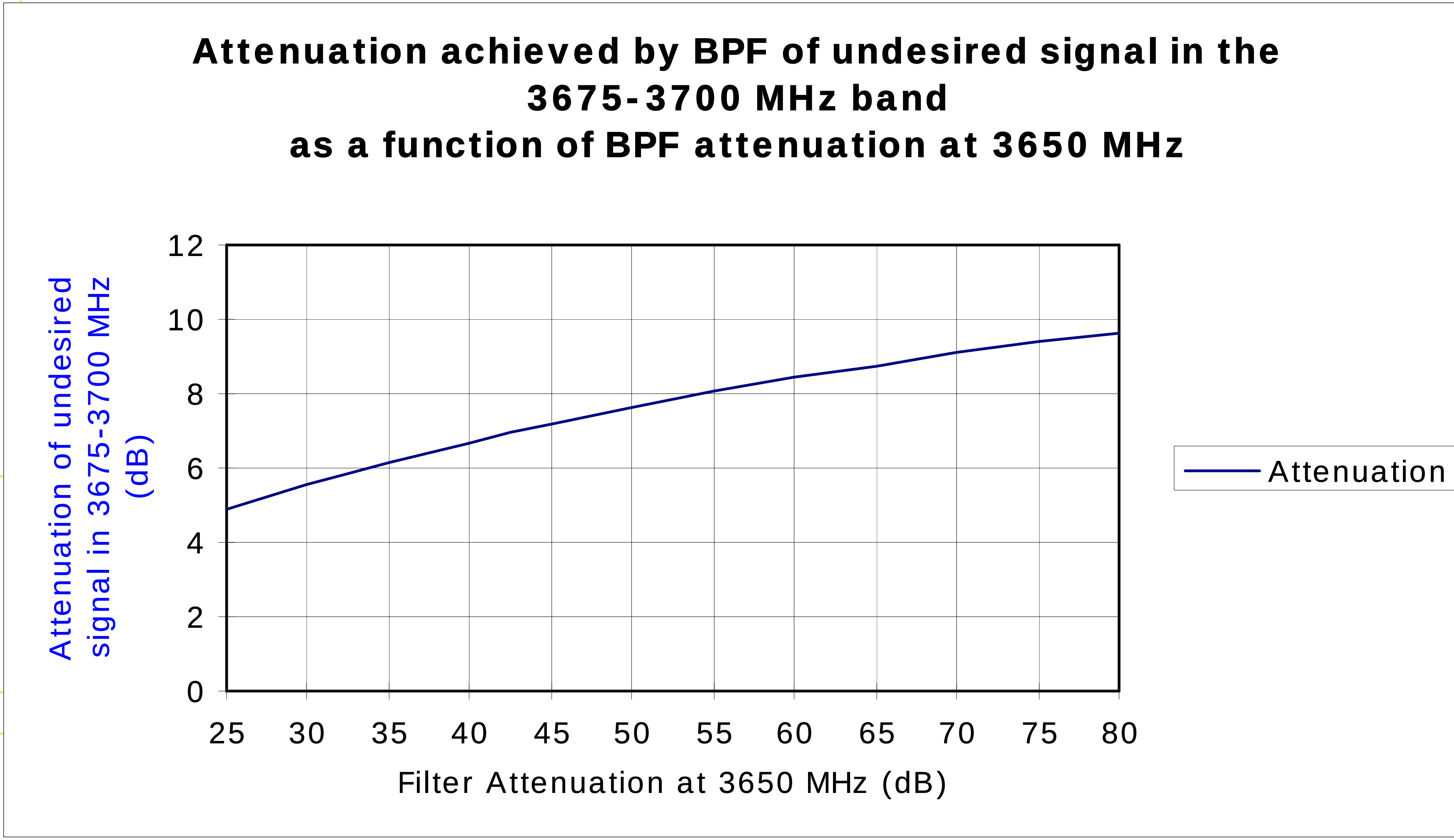


Filter analysis Assumptions:

- Readily available Band-Pass Filters (BPF) achieve ~25 dB attenuation at 3650 MHz – They are designed to have a flat frequency response over the 3700-4200 MHz band
- The analyzed BPF has the following characteristics:
  - Has ~ 1 dB attenuation at 3700 MHz
  - Has "X" dB attenuation at 3650 MHz, where "X" is variable
- Different values of "X" are examined
- The ratio (in dB) between the total power in the 3650-3700 MHz band and the power in this band that reaches the LNB when a BPF is inserted is computed and plotted as a function of "X"

Filter analysis results:

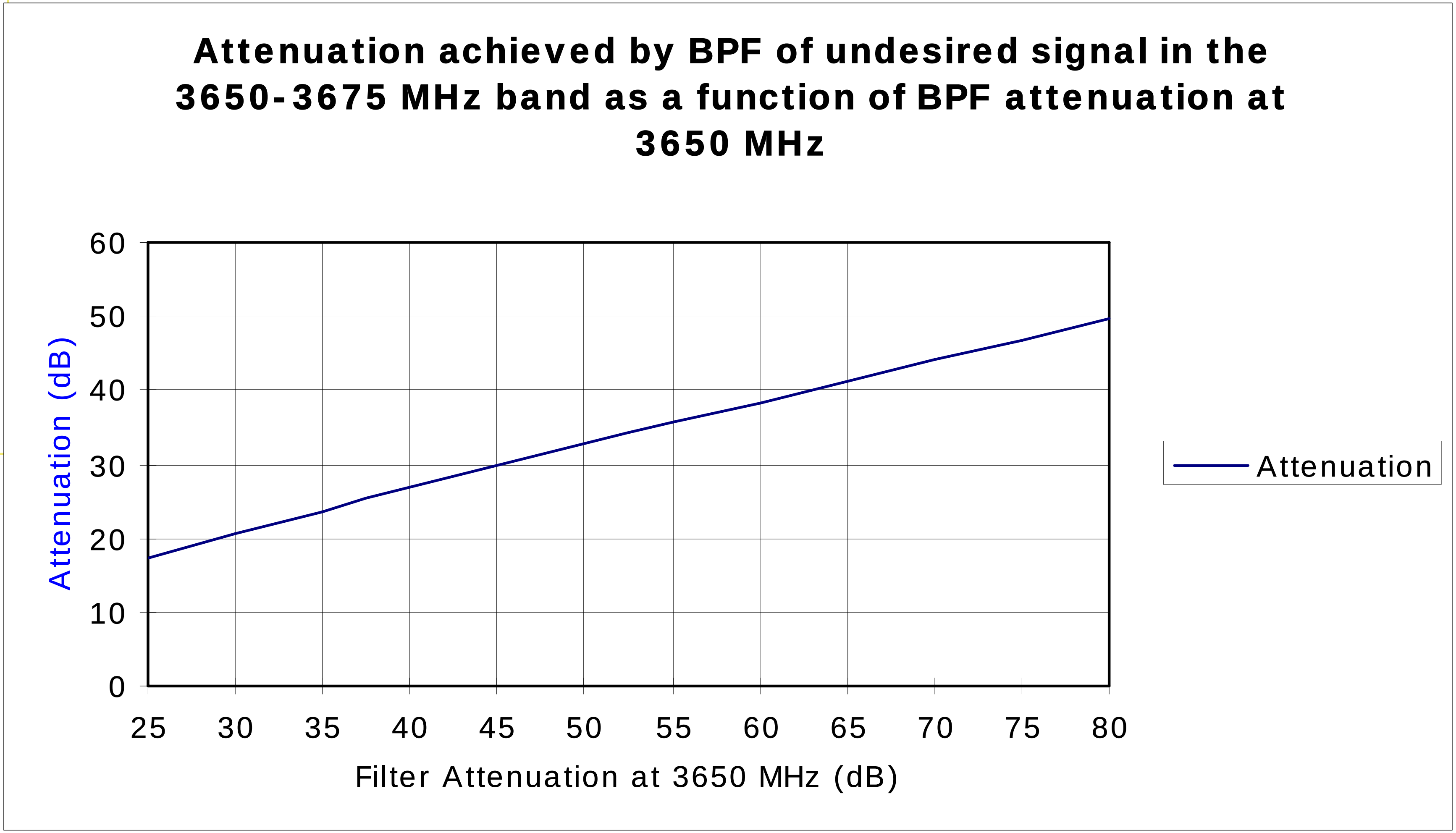
- Most of the unwanted power reaching the LNB comes from the 25 MHz immediately below 3700 MHz (i.e., 3675-3700 MHz)
- A typical 25-dB BPF can attenuate an undesired signal in the 3675-3700 MHz band by **4.9 dB**
- A 50-dB BPF can attenuate an undesired signal in the 3675-3700 MHz band by **7.6 dB**
- BPFs can help but are **inadequate** to solve the LNB saturation problem
- Moreover, there are design limits on the attenuation that can be achieved at 3650 MHz while keeping the physical size of the BPF acceptable and practical *(filter weight and size can stress the antenna feed structure)*
- A sharp drop-off (high “X” value) will impact other parameters of the BPF (e.g. group delay response)


Attenuation achieved by BPF of undesired signal in the 3675-3700 MHz band as a function of BPF attenuation at 3650 MHz
Attenuation of undesired signal in 3675-3700 MHz (dB)
12
10
8
6
4
2
0
25
30
35
40
45
50
55
60
65
70
75
80
Filter Attenuation at 3650 MHz (dB)
Attenuation

LNB saturation analysis if 25 dB filter is used:

Distance to Victim Antenna (meters)	Free Space Loss (dB)	Attenuation of 3650-3700 MHz signal due to BPF (dB)	Signal Level @ Victim Antenna (dBm)	Arrival Angle of Interferer (°)	Gain of Victim E/S Antenna in direction of Interferer (dBi)	Effective Signal Level of Interferer @ Victim Antenna (dBm)	Total Power of Satellite Signal + Interferer (dBm)	Exccedance above LNB Saturation Level (dB)
50	77.7	4.9	-38.6	5	11.5	-27.1	-27.08	**27.9**
200	89.7		-50.6	5		-39.1	-39.12	**15.9**
600	99.3		-60.2	5		-48.7	-48.65	**6.3**
1000	103.7		-64.6	5		-53.1	-53.07	**1.9**
50	77.7	4.9	-38.6	15	2.6	-36.0	-36.01	**19.0**
200	89.7		-50.6	15		-48.1	-48.04	**7.0**
600	99.3		-60.2	15		-57.6	-57.50	**-2.5**
1000	103.7		-64.6	15		-62.0	-61.77	**-6.8**
50	77.7	4.9	-38.6	30	-4.9	-43.5	-43.53	**11.5**
200	89.7		-50.6	30		-55.6	-55.52	**-0.5**
600	99.3		-60.2	30		-65.1	-64.61	**-9.6**
1000	103.7		-64.6	30		-69.6	-68.27	**-13.3**

- Assumptions are the same as used before when no filter was used


Attenuation achieved by BPF of undesired signal in the 3650-3675 MHz band as a function of BPF attenuation at 3650 MHz
Attenuation (dB)
60
50
40
30
20
10
0
25
30
35
40
45
50
55
60
65
70
75
80
Filter Attenuation at 3650 MHz (dB)
Attenuation

Observations:

- When the higher power signals are further away from 3700 MHz, the BPF ability to reject is greatly improved
- BPFs cannot sufficiently attenuate a signal that is immediately adjacent to the pass band edge and that is orders of magnitude more powerful than the desired signal
- The following table shows the amount of rejection that two types of BPFs exhibit toward a higher power signal (25 watts/25 MHz) as a function of its proximity to the pass-band edge of the BPF

Placement of undesired signal / Type of BPF	3650-3700 MHz	3650-3675 MHz
25-dB BPF	4.9	17.4
50-dB BPF	7.6	32.6

LNB saturation analysis if 25 dB filter is used and Wireless Broadband signals are 25 Watts/25 MHz in 3650-3675 MHz and 1 Watt/25 MHz in 3675-3700 MHz

Distance to Victim Antenna (meters)	Free Space Loss (dB)	Attenuation of 3650-3700 MHz signal due to BPF (dB)	Signal Level @ Victim Antenna (dBm)	Arrival Angle of Interferer (°)	Gain of Victim E/S Antenna in direction of Interferer (dBi)	Effective Signal Level of Interferer @ Victim Antenna (dBm)	Total Power of Satellite Signal + Interferer (dBm)	Exceedance above LNB Saturation Level (dB)
50	77.7	17.4	-51.1	5	11.5	-39.6	-26.78	**15.4**
200	89.7		-63.9			-51.6	-38.82	**3.4**
600	99.3		-72.7			-61.2	-48.35	**-6.0**
1000	103.7		-77.1			-65.6	-52.77	**-10.0**
50	77.7	17.4	-51.1	15	2.6	-48.5	-35.71	**6.5**
200	89.7		-63.9			-60.6	-47.74	**-5.4**
600	99.3		-72.7			-70.1	-57.21	**-13.7**
1000	103.7		-77.1			-74.5	-61.49	**-16.4**
50	77.7	17.4	-51.1	30	-4.9	-56.0	-43.23	**-1.0**
200	89.7		-63.9			-68.1	-55.22	**-12.1**
600	99.3		-72.7			-77.6	-64.35	**-17.6**
1000	103.7		-77.1			-82.1	-68.05	**-18.5**

Proposed approach to reduce likelihood of LNB saturation

- Allowing Wireless Broadband Devices to transmit at full power (25 Watts/ 25 MHz) across the full 50 MHz band will be detrimental to FSS
- It is impossible to effectively filter an undesired signal that is adjacent to the edge of the BPF pass band
- Full power operation of Wireless Broadband Devices (25 Watts/ 25 MHz) needs to be restricted to the lower 25 MHz of the 3650-3700 MHz band
- This will still require the installation of filters in FSS earth stations and will not completely eliminate the probability of interference

Summary

- OOBE limit for Wireless Broadband Devices should be equal to that currently applicable to unlicensed devices, i.e., -71.25 dBW/MHz

- Full power operation of Wireless Broadband Devices (25 Watts/ 25 MHz) needs to be restricted to the lower 25 MHz of the 3650-3700 MHz band (this would require installation of filters in selected earth stations and would not completely eliminate the likelihood of LNB saturation)